Blood, Lymph & Immune

Phase I

Faculty of Medical Sciences
University of Sri Jayewardenepura

Blood & Immune System – Phase I

Introduction

If you or someone known to you has donated blood to save a life you will understand that blood is life giving. You will need to know about blood, lymph and the immune system in your work as a doctor in the future.

As a first year medical student it is important that you learn the normal structure & function of the body. You will be encouraged to learn the Anatomy, Biochemistry and Physiology of blood, lymph & immune systems in an integrated manner. You will also learn to relate this knowledge of the basic sciences to their clinical applications, so that it will help you in your future work as doctors.

In order to help you, we have designed the module around key health related real life situations you will encounter. Read these scenarios and note down what questions arise in your mind. Make a note of what you would like to know if you are faced with these situations. You may do this on your own or collectively. These worksheets will help you understand the importance & relevance of learning the different components of this module. You will also understand better what knowledge components you can gain from the lectures, practicals, small group discussions, tutorials, fixed learning modules, IT sessions & sessions in the Language & communication Labs.

We hope you will enjoy this module.

Overall aim

The overall aim of this module is to help you acquire the necessary knowledge in the basic sciences that underlie the practice of haematology & immunology.

Process

The module is structured around three key areas

a. Anaemia: This is a very common clinical situation that you will encounter in your work as doctor. Learning around this will help you contextualize your learning of red blood cells & haemoglobin.
b. Bleeding diseases: Learning around these, often life threatening conditions will help you understand better why you need to learn about platelets & haemostasis.
c. Immune reactions: This is a common situation that you will encounter as a doctor. Learning around these scenarios will help you contextualize the importance of understanding the body's defence mechanisms.

General Objectives

At the end of the module you should be able to:

Apply the knowledge gained to common haematological disorders to explain the disordered physiology, biochemistry & anatomy in the given situation

In order to achieve the above, you should be able to:

- explain the structure & function of blood & its constituents
- describe the haemostasis mechanisms in the body
- conduct a platelet count and interpret basic haematological tests
- conduct a blood grouping test and explain the consequences of mismatching
- describe the structure and functions of lymphoid tissue/ organs & immune cells
- describe the functions of the normal immune system.

Main Content areas

1. Blood
2. Plasma and serum
3. Haemoglobin
4. Red Blood Cells
5. Platelets
6. Haemostasis
7. Blood groups
8. White Blood Cells
9. Lymphatic system
10. Immunology

Procedural skills

1. Conduct a RBC count and WBC count
2. Conduct a Platelet count
3. Perform a finger prick and draw a blood film
4. Perform blood grouping test (tube method)
5. Perform a venepuncture

Members of the module committee

Chairperson	- Dr. Roshini Peiris-John	- Physiology
Convener	- Dr. Sugandhika Suresh	- Biochemistry
Members	- Dr Indira Wijesiriwardene	- Pathology
	(Chairperson - Blood & immunology - phase II)	
	- Dr. S .D. Kamaladasa	- Medicine
	- Dr. Himanshu Waidyasekera	- Physiology
	- Dr. Shalindra Ranasinghe	– Parasitology
	- Dr. M S M Rizny	- Anatomy
	- Dr. U G Chandrika	- Biochemistry

Real life situation 1 – Anaemia

The vegetable vendor at the Sunday pola your mother visits has heard that you are a medical student. She is a young mother with 5 children and has many questions regarding her health. She complains of being tired all the time. You hesitantly tell her that you are only just starting your medical course and that you think it is best that she goes to an OPD of the nearby hospital.

A few weeks later she tells your mother that she visited the OPD and the doctor ordered some blood tests. She was later told that she had anaemia. Your mother informs you over the phone that the vendor is waiting for you to return to your village so that she can show you her reports and discuss her health with you.

You are now keen on learning something more about anaemia. To your relief you realize that anaemia is to do with blood and this is the first system based module you will be learning in your first year at medical school. You quickly list what you already know on the subject and then you list out what more you need to learn on anaemia.

You learn as much as possible during your module and now you can't wait to get back home and visit the pola.

You are of course aware that you may not be in a position to answer all her questions. You make a note of sections you will like to learn in the future.

Real life situation 2 – Bleeding disease

When you visit the Sunday pola the vegetable vendor now tells you she has an entirely new problem. Her youngest child who is a son after 4 daughters has developed fever and she has noticed that when he brushes his teeth he bleeds from his gum. She wants to know if it is related in any way to her condition. You advice her to take her child to the hospital as soon as possible.

You quickly make a note to read your notes and recall what you learnt about bleeding disease in your blood and immunology module. You recall all you learnt about interpretation of blood reports.

Real life situation 3 – Immune reactions

Your roommate has got chickenpox. You are worried whether you will also get the infection. You discuss with another friend about the possibilities.

- Can your immune system resist and prevent the infection?
- Have you got chickenpox in childhood? If so, why don't you get it again?
- Have you been vaccinated? If not what should you do in this situation?

Your friend mentions that he is "allergic to penicillin". It was first diagnosed when he developed difficulty in breathing and a rash following an injection.

You make a note of all the questions that come to your mind and hope that you will find some of the answers during the module.

A – Must Know **B – Good to Know** **C – Nice to Know**

Intermediate Objectives	Broad content Area	Dept	Learning activity	Duration
1. List the constituents of blood 2. Outline the function of blood 3. List the sites of production of blood cells in the fetus and adult 4. Outline the process of haemopoiesis indicating the roles of stem cells and sites of action of interleukins, erythropoietin, colony stimulating factor	**Blood (A)** - Constituents of blood - Functions - Sites of production of blood cells in fetus & adult - Process of haemopoeisis	Phys	Lecture	1 hr
5. Distinguish between plasma and serum 6. List the components/characteristics of α_1, β_1 , β_2, γ globulins pre-albumin and albumin. 7. Explain the main peak in serum electrophoresis and interpret patterns 8. List the functions of plasma proteins	**Plasma and serum** - Difference between the two **(A)** - Plasma Proteins Types **(B)** Components/Characteristics **(B)** Functions of albumin, globulins and fibrinogen **(A)**	Bio	Lecture FLM	1½ hrs
9. State what clotting factors are 10. Explain acute phase response, functions of Zn+ 11. State what para proteins and Bence-Jones proteins are and explain the occurrence of Bence-Jones proteins 12. Explain the role and interconversion of lipoproteins, LDL,HDL 13. Explain the effects of oxidized LDL	- Clotting factors **(A)** - Acute phase response **(B)** - In normal, acute phase response, paraproteinaemia **(B)** - Occurrence of Bence-Jones Proteins & Para proteins **(C)** - Role and interconversion of lipoproteins **(B)** - Effects of oxidized LDL **(B)**	Bio	Lecture	2 hrs

Intermediate Objectives	Broad content Area	Dept	Learning activity	Duration
14. Outline the basic structure of the RBC 15. State the lifespan of RBC in circulation and normal RBC count 16. Give an outline of the process of erythropoiesis and state the timeline 17. Name the factors essential for erythropoiesis and explain the role of these factors in this process 18. State the sites of synthesis of erythropoietin and explain its role in the production of RBC's 19. Explain the regulation of erythropoeisis 20. Outline the role of Glutathione & Spectrin in maintenance of the RBC structure. 21. Explain the process of RBC breakdown at the end of their life span inclusive of Hb breakdown and bilirubin production and excretion from the body 22. Compare and contrast intra-vascular and extra-vascular haemolysis in relation to the – causes, mechanism, and the changes seen in blood and the urine in the 2 processes	**RBC** - Structure of RBC **(A)** - Process of Erythropoiesis **(A)** - Role of nutrients (Fe, Vit B_{12}, Folate) and hormones in erythropoiesis **(A)** - Role of Erythropoeitin **(A)** - Regulation of erythropoiesis including role of hypoxia **(A)** - Glutathione in combating oxidative stress; Spectrin in providing mechanical support of RBC structure **(B)** - RBC breakdown & the excretion of breakdown products **(A)** Formation of conjugated bilirubin **(A)** - Intra- & extra-vascular haemolysis in relation to **(A)** Causes & mechanisms & Changes in blood & urine	Phys Bio Phys Bio	lecture	2½ hr
23. Conduct a RBC count 24. Explain what RBC indices are and calculate these from given blood count results	- RBC Count **(A)** - RBC indices (MCV, MCH, MCHC) **(A)**	Phys	Practical	3hrs
25. Define anaemia 26. Explain how anaemia can be produced due to – a. Excessive blood loss b. Inadequate production of RBC c. Excessive destruction of RBC	- Anaemia **(A)** in blood loss in reduced production of RBC in excessive destruction of RBC	Phys	lecture	1hr

Intermediate Objectives	Broad content Area	Dept	Learning activity	Duration
27. List the common symptoms and signs of anaemia and explain their physiological basis	Physiological basis of symptoms & signs in anemia **(A)** Physiological basis of lab findings in anemia - Hb concentration, PCV, MCV, MCHC, MCH **(A)** - Peripheral blood film(draw)**(A)** - ESR **(A)** - Serum Iron and TIBC **(A)** - Osmotic fragility test and **(B)** - Haemoglobin electrophoresis **(B)**	Phys	lecture Practical + FLM	1/2hr 3hrs
28. Explain the physiological basis for changes seen in commonly used haematological and other laboratory investigations in the different types of anaemia				
29. Explain how deficiency of dietary factors iron, Vit B12, and folate produce their corresponding type of anaemia	Pathophysiology of anaemia **(A)** in dietary deficiency in bone marrow disease in excessive destruction/ blood loss	Phys	SGD	2 hrs
30. State how anaemia occurs bone marrow disease				
31. Outline the pathophysiological basis of selected causes of haemolytic aneamia including – a. Intra-erythrocytic causes – congenital spherocytosis, G6PD deficiency, sickle cell anaemia and Thalassemias b. Extra-erythrocytic causes – malaria, immune disorders				
32. Define polycythemia	Polycythemia (I^{ry} and II^{ry}) **(C)** - differences - physiological basis of effects	Phys	Lecture	1/2hr
33. State the main difference between primary and secondary types of polycythaemia and give examples of both types				
34. Explain the physiological basis of the effects of polycythemia				

Intermediate Objectives	Broad content Area	Dept	Learning activity	Duration
35. Describe the subunit structure of HbA and HbA2 in adult and HbF in the fetus and compare the functional differences between adult and fetal Haemoglobin	**Haemoglobin** - Structure & function of HbA, HbA2 & HbF **(A)**	Bio	Lecture	1hr
36. State the time line for the transition from HbF to HbA	- Time line for transition **(C)**			
37. Explain the pathway of synthesis of Heme (porphyrias)	- Synthesis of haem **(C)**			
38. Explain the importance of iron in Hb synthesis	- Importance of Fe **(A)**			
39. Describe the reactions of Hb – with O_2, CO_2, 2,3 DPG and CO and explain how temperature and pH influence these reactions	- Reactions of Hb with O_2, CO_2, 2,3-BPG, etc **(A)**	Phys	Lecture	1hr
40. State the normal values of Hb in neonates & adults and state the principles of Hb estimation	- Concentrations in man & principles of measurement **(A)**			
41. Outline the production of platelet from megakaryocytes	**Platelet** - Production on bone marrow **(A)**	Phys	Lecture	½ hr
42. Explain the functional aspects of the morphology of the platelets – including contents of dense and alpha granules	- Structure **(C)** & functions **(A)**			
43. Describe the functions of platelets & formation of the platelet plug	- Formation of platelet plug– platelet adhesion, activation and aggregation **(A)**			
44. Explain the difference between the thrombocytopenia, thrombocytosis and platelet function defects	- Thrombocytopenia **(A)**, thrombocytosis & platelet function defects **(B)**			
45. State the ranges of platelet count in adults and children and conduct a platelet count	- Platelet count **(A)**	Phys	Practical	3hrs

Intermediate Objectives	Broad content Area	Dept	Learning activity	Duration
46. Define Haemostasis 47. List the main mechanism of haemostasis 48. Describe the role played by vascular endothelium and platelets in haemostasis 49. Describe the process of fibrin clot formation (Intrinsic , extrinsic and common pathway) 50. Explain the anti-clotting mechanisms 51. Explain briefly how anti-clotting mechanisms prevent clot formation in a healthy person 52. Explain the use of anticoagulants in preventing clot formation in a. the laboratory(EDTA) & b. patients(Warfarin & Heparin) 53. Explain the mechanism of fibrinolysis	**Haemostasis** - Mechanism **(A)** - Vascular response **(A)** - Platelet plug **(A)** - Clotting pathways **(A)** - Anti-clotting pathway **(A)** - Balance between clotting and anti-clotting **(A)** - Anti coagulants **(A)** - Fibrinolysis **(A)**	Phys	Lecture	2 hrs
54. Explain the physiological basis for the use of the following tests a. Bleeding time b. Clotting time c. Prothrombin time d. Activated partial thromboplastin time e. Thrombin time	- Physiological basis of tests **(A)** Bleeding time Clotting Prothrombin time APTT	Phys	Practical	3hrs
55. Explain the physiological (& biochemical) basis for the disordered haemostasis in a. Liver disease b. Vitamin K deficiency c. Haemophilia d. Disseminated intravascular coagulation	Physiological & biochemical basis of disordered haemostasis in selected disease states **(A)**	Phys	SGD	2hrs

Intermediate Objectives	Broad content Area	Dept	Learning activity	Duration
56. List the 2 main blood grouping systems (ABO and Rh system)	**Blood Groups** - Main blood groups & the role of antigens & antibodies **(A)** - Inheritance **(A)** - Blood transfusion **(A)** Principles Cross -matching Physiological basis of the effects of mismatching **(A)** Blood grouping test **(A)** Coomb's test **(C)**	Phys	Lecture Tutorial	2 hrs 1 hr
57. Define antigens and antibodies and explain how the different ABO blood group types and Rh group are determined (by their distribution)				
58. Outline the inheritance of ABO and Rh blood group systems.				
59. Explain the importance of matching the ABO and Rh systems in blood transfusion				
60. Explain how donors and recipients of different blood groups are matched for blood transfusion				
61. Explain the physiological effects of a. incompatible blood transfusion b. haemolytic disease of the newborn				
62. Perform a blood grouping test (tube test) and interpret results		Phys	Practical + FLM	3hrs
63. Explain the principles of the direct and indirect Coomb's test				

Intermediate Objectives	Broad content Area	Dept	Learning activity	Duration
64. List the different types of WBC in peripheral blood and outline the process of WBC production	**WBC** - WBC production in bone marrow **(A)**	Phys	Lecture	1hr
65. Outline the functions of each WBC type	- Functions of each type **(A)**			
66. Describe the morphology of neutrophil, basophil, oesinophil, mast cells macrophages & NK cells	- Identification of WBC types **(B)**	Anat Phys	Practical + FLM	3hrs
67. State the normal WBC count and differential count and do a WBC count	- WBC Count & Differential count **(A)**			
68. Describe the gross anatomy and histology of thymus, bone marrow, lymph nodes, spleen, mucosa associated lymph tissue and lymphatic drainage.	**Lymphatic system** - Structure & function of lymphoid tissue/organs **(A)**	Anat	Practical (Histo)	3 hr
69. Describe B and T lymphocytes	- Structure T & B lymphocytes **(A)**			
70. Describe the functions of B & T lymphocytes & lymphocyte recirculation	- Functions of T & B lymphocytes, mast cells, macrophages & NK cells **(A)**	Phys	Lecture	1hr
71. Describe the functions of mast cell, macrophages and NK cells.				

Intermediate objective	Broad content area	Dept	Learning activity	Duration
	Immunology			
72. Describe the structure and function of the different types of immunoglobulins	- Structure of immunoglobulin **(B)** - Function of immunoglobulin **(A)**	Phys	Lectures	5 hrs
73. Explain cell homing and adhesion molecules	- Cell homing **(B)**		Tutorial	1 hr
74. Explain complement factors & explain complement system	- Complement sys **(B)**			
75. Outline the systems involved in the immune mechanism	- Systems involved in immune mechanisms **(A)**			
76. Define immunity	- Components involved in innate immune mechanisms **(A)**			
77. Explain components of innate body defenses	- mechanical barrier - mechanical removal - germicidal activity - normal flora - body fluids - phagocytosis			
78. Explain the components of acquired body defenses	- Acquired immune mechanisms **(A)** antibody mediated immunity cell mediated immunity			
79. Explain primary and secondary immune response	- I^{ry} & II^{ry} Immune mechanisms **(A)**			
80. Describe active and passive immunity	- Active & Passive immunity **(A)**			
81. Define hypersensitivity and explain briefly the different types of hypersensitivity reactions	- Types of hypersensitivity **(A)**			
82. Describe HLA typing and its importance	- HLA typing **(B)**			
83. Outline the immune deficiency states (primary & secondary)	- I^{ry} & II^{ry} Immune deficiencies **(A)**			
84. Briefly explain the basis of development of an immune deficiency state HIV/AIDS and its clinical significance	- HIV /AIDS and its clinical Significance**(A)**			

References

1. Review of Medical Physiology (William F Ganong) – Published by Appleton & Lange
   Section on Circulation; Chapter – Circulating body fluids

2. Pathophysiology of diseases (Ganong/ Lange)
   Chapter on blood disorders

3. Wheater's functional histology (B Young, J W Heath) – Published by Churchill Livingstone
   Chapters on blood, Immune system

4. Clinical Chemistry (William J Marshall, Stephen K Bangert)
   Chapters on,
   a) Hydrogen homeostasis and blood gases
   b) Plasma proteins and enzymes
   c) Lipids, lipoproteins and cardiovascular disease

5. Harper's Biochemistry (R K Murray, D K Granner, P A Mayes, V W Rodwell) - Published by Appleton & Lange

   Chapters on plasma protein, immunoglobulins and blood coagulation.

Additioal reading material

1. Essential haematology by A V Hoffbrand, J E Pattit and P A H Moss.Blackwell publishing company.Latst Edition.